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THE MODERN CONCEPTION OF THE STRUCTURE AND CLASSIFICATION OF DESMIDS,

WITH A REVISION OF THE TRIBES, AND A REARRANGEMENT OF
THE NORTH AMERICAN GENERA

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WITH ONE PLATE

The recent revision of the Green algae in Engler and Prantl's "Pflanzenfamilien" by Professor Wille, the eminent Swedish algologist, brings together in compact form the results of the work of many investigators. Taking this admirable monograph as a basis and bringing to my aid the monograph of the Bacillariales by Professor Schuett in the same publication, I have ventured to attempt to carry out Wille's work somewhat nearer to what appears to me must be its logical conclusion. I should associate in one group (Conjugatae) the families Zygnemaceae (including Mesocarpaceae of some authors), Desmidiaceae, and Bacillariaceae (all of holophytic species), and to this group I assign ordinal rank. Until quite recently I have associated with these the families Mucoraceae and Entomophthoraceae, composed of hysterozytic plants, in accordance with the theory that they are colorless, degenerate relatives of the holophytic families just named. However, further study of the problem has led to the conclusion that Mucoraceae and Entomophthoraceae have little affinity with the families of the Conjugatae, and that they are to be removed to that remarkable group of hysterozytic families (Saprolegniaceae, Cladochytriaceae, Ancylistaceae and Peronosporaceae) in the Siphonales, which appears to have sprung from or near the Vaucheriaceae. With these relationships this paper is not directly concerned, and they may be passed without further discussion.

The families of the Conjugatae (Zygnemaceae, Desmidiaceae, and Bacillariaceae) are here regarded as consisting of

typically filamentous plants, as is well illustrated in the common Conjugata (*Spirogyra*) of the pools. As shown in another paper* many diatoms are filamentous plants, and in those species in which the cells occur singly we may regard this condition as the result of the early *solution* of the filament. In the present paper it is assumed that the Desmids, also, are typically filamentous, or in other words, that they have been derived from filamentous forms, a structure which is still maintained in a considerable number of genera, and that the unicellular condition is derived from this structure by the early separation of the cells, or as expressed above, by the *solution* of the filament.

This conception necessitates an arrangement of the genera somewhat different from that adopted by Wille, without, however, seriously disturbing their inter-relationships. It is not difficult to see that the family is easily separable into three quite well-marked groups of genera, which we may, perhaps, regard as tribes. Thus the filamentous forms may be brought together (as indeed was done by Hansgirg and De Toni a dozen years ago), and in like manner the unicellular forms may be easily separated into two tribes, (a) those with elongated cells, little if at all constricted, and (b) those with broad, deeply constricted cells. To the first of these three tribes I have given the name DESMIDIEAE, preferring this to EUDESMIDIEAE, used by Hansgirg for the name of his equivalent sub-family. The second tribe I name ARTHRODIEAE (from the genus *Arthrodia*, heretofore known as *Closterium*, but clearly antedated by Rafinesque's name) while for the third the name COSMARIEAE.

In accordance with the foregoing conclusions I have drawn up the technical diagnosis of the family in the following terms:

FAMILY DESMIDIACEAE

Cells bright green, in unbranched filaments, cylindrical, angled or flattened in cross section, and quadrangular, rounded, or lobed and often constricted in side view; or more commonly separating early into isolated individuals which are similarly shaped, or symmetrically lobed or branched in side view; cell wall composed of cellulose, commonly finely

*The Modern Conception of the Structure and Classification of Diatoms, with a revision of the tribes and a rearrangement of the North American genera; in Transactions of the American Microscopical Society, Vol. XXI, p. 61.

porous, and often covered with a gelatinous layer, and composed in most genera of two halves which adhere to each other at the middle of the cell, which is usually constricted; propagation by the transverse fission of each cell into two equal, but unsymmetrical daughter cells, which soon grow to be symmetrical; generation by the rupture of the outer walls of two contiguous cells, and the protrusion of a thin-walled tube from each, these fusing and uniting their contents into a resting spore (zygote) from which on germination one, two, four, or eight new cells are formed.—Minute freshwater plants, floating free in the water of quiet pools, or entangled with *Sphagna*, mosses and other aquatic plants.

KEY TO THE TRIBES.

- A. Cells in unbranched filaments, Tribe 1. *Desmidiaceae*.
- B. Cells solitary,
 - I. Cells elongated; not at all, or but moderately constricted, Tribe 2. *Arthrodiaceae*.
 - II. Cells broad, deeply constricted, Tribe 3. *Cosmarieae*.

TRIBE 1. DESMIDIEAE

Cells in unbranched filaments, from much elongated to shorter than broad, cylindrical to angular or flattened, and from not at all to deeply constricted; filaments naked or enclosed in a hyaline sheath.

KEY TO THE GENERA.

- I. Filaments naked (without a sheath),
 - a. Cells cylindrical,
 - 1. Chromatophore single, axial, 1. *Gonatozygon*.
 - 2. Chromatophores three, parietal, spiral, 2. *Genicularia*.
 - b. Cells barrel-shaped, 3. *Gymnozyga*.
 - c. Cells quadrangular, deeply constricted, 4. *Phymatodocis*.
- II. Filaments surrounded by a hyaline sheath,
 - a. Cells not constricted, or very little,
 - 1. Filaments cylindrical, 5. *Hyalotheca*.
 - 2. Filaments 3- to 4-angular, 6. *Desmidium*.
 - b. Cells deeply constricted, filaments flattened,
 - 1. Cells unarmed, 7. *Sphaerososma*.
 - 2. Cells armed with several divergent horns, 8. *Onychonema*.

1. *Gonatozygon* De Bary. Cells elongated-cylindrical, or truncate-fusiform, attached to one another in an unbranched filament, which has no sheath, not at all constricted in the middle; chromatophore one, axial, undulated.—Small desmids of few species, rarely seen.

2. *Genicularia* De Bary. Cells elongated-cylindrical, attached to one another in an unbranched filament, which has no sheath, not at all constricted in the middle; chromatophores three, parietal, spiral, sometimes confluent or irregular.—Small desmids of few species, rarely seen.

3. *Gymnozyga* Ehrenberg. Cells oblong, barrel-shaped, each with two median hoop-like ridges, attached to one another in an unbranched filament, which has no sheath, not constricted in the middle; chromatophores of several axial plates with divergent wings.—Small desmids of few species, several of which are common in quiet waters.

4. *Phymatodocis* Nordstedt. Cells oblong, truncate, quadrangular in transection, attached to one another in an unbranched filament, which has no sheath, deeply constricted in the middle; chromatophores not known.—Small desmids, rarely seen.

5. *Hyalotheca* Ehrenberg. Cells short-cylindrical, attached to one another in an unbranched filament, which is surrounded by an ample, colorless sheath, very slightly (obtusely) constricted in the middle; chromatophores of several axial plates with divergent wings.—Small desmids of few species, several of which are frequent in some portions of this country.

6. *Desmidium* Agardh. Cells oblong, truncate, triangular or quadrangular in cross-section, little or not at all constricted in the middle, attached to one another in an unbranched filament, which is surrounded by a hyaline sheath; chromatophores of three or four longitudinal plates lying in the angles of the filament.—Small desmids, common throughout the country.

7. *Sphaeroszoma* Corda. Cells compressed, deeply constricted in the middle, unarmed, ends rounded or truncate, slightly attached to one another in a lobed, unbranched filament, which is surrounded by a hyaline sheath; chromatophores quadriradiate.—Small desmids, some species of which are common in ponds and ditches.

8. *Onychonema* Wallich. Cells compressed, deeply constricted, armed with divergent horns, ends rounded or truncate, slightly attached to one another in a lobed, unbranched filament, which is surrounded by a hyaline sheath; chromatophores quadricellate.—Small desmids, rarely seen.

TRIBE 2. ARTHRODIEAE

Cells solitary, elongated, cylindrical to fusiform; transection circular, not at all to moderately constricted; cells sheathless.

KEY TO THE GENERA.

I. Cells not constricted, transection circular,

a. Cells straight,

1. Chromatophores of one or more spiral bands,

9. *Entospira*.

2. Chromatophore a single axial plate,

10. *Mesotaenium*.

3. Chromatophores of several axial plates, with divergent wings,

11. *Penium*.

b. Cells more or less falcate, or semi-lunate,

12. *Arthrodia*.

II. Cells straight, moderately constricted, transection circular.

a. Chromatophores axial,

1. Cells short-cylindrical or fusiform, ends rounded, emarginately incised,

13. *Tetmemorus*.

2. Cells long-cylindrical, much elongated, ends truncate or rounded or 3-lobed,

14. *Docidium*.

b. Chromatophores axial,

15. *Pleurotaenium*.

9. *Entospira* Brebisson (*Spirotaenia* Brebisson).^{*} Cells solitary, sometimes aggregated in a gelatinous matrix, straight, oblong-cylindrical or fusiform, not constricted in the middle; transection circular, ends rounded or acuminate; chromatophores of one or more spiral parietal bands.—In pools, ponds, and in wet mosses.

10. *Mesotaenium* Naegeli. Cells solitary, sometimes aggregated in a gelatinous matrix, short-cylindrical, elliptical or ovate, not constricted in the middle; transection circular,

^{*}Of these two names by the same author, *Entospira* has the priority, having been proposed by him in 1847 in Kuetzing's *Tabulae Phycologicae*, while *Spirotaenia* did not appear until 1848, in Ralf's *British Desmidiaceae*.

ends rounded; chromatophore a single axial plate or ribbon, sometimes divided in the middle.—In pools, on wet rocks, walls or damp ground.

11. *Penium* Brebisson. Cells solitary, sometimes aggregated in a gelatinous matrix, straight, cylindrical, or fusiform, not constricted in the middle; transection circular, ends rounded or somewhat truncate; chromatophores of several axial plates, with divergent wings.—Large desmids, 11 to 80 μ in diameter, and 6 to 10 times as long, common in pools and springs.

12. *Arthrodia* Rafinesque, (*Closterium* Nitzsch).^{*} Cells solitary, more or less falcate or lunate, incurved (rarely nearly straight), fusiform or cylindraceous, not constricted in the middle; transection circular, ends acuminate; chromatophores of several axial plates, with divergent wings.—Medium to large sized desmids, 3 to 110 μ in diameter, and from 5 to 20 times as long, common in pools and springs.

13. *Tetmemorus* Ralfs. Cells solitary, straight, cylindrical, or fusiform, moderately constricted in the middle; transection circular, ends rounded, narrowly emarginately incised; chromatophores axial.—Rather large desmids, common in ponds.

14. *Docidium* Brebisson. Cells solitary, straight, oblong—cylindrical, moderately constricted in the middle, usually long (6 to 30 times their diameter); transection circular, ends truncate, rounded, three-lobed and three-spined; chromatophores axial, of two to four radiating bands.—Large or medium sized desmids, frequent in ponds.

15. *Pleurotaenium* Naegeli. Cells solitary, straight, cylindrical, more or less constricted in the middle; transection circular, ends truncate; chromatophores parietal.—Large desmids, some species of which are common in ponds.

TRIBE 3. COSMARIEAE

Cells solitary, broad, more or less flattened; transection rounded to angular, oblong and elliptical, deeply constricted, the half-cells from entire to many-lobed; cells sheathless.

^{*} Nitzsch's name, *Closterium*, was first proposed in 1817, while Rafinesque's name, *Arthrodia*, was used four years earlier, i. e. 1813; hence the latter having clear priority, must be used for these beautiful organisms.

KEY TO THE GENERA.

- I. Cells short-cylindrical or orbicular, transection rounded or oblong, half-cells not lobed,
 - a. Unarmed,
 - 1. Solitary,
 - a. Chromatophores axial, radiating, 16. *Cosmarium*.
 - b. Chromatophores parietal, longitudinally laminiform, 17. *Pleurotaeniopsis*.
 - 2. Joined in gelatinous, branching threads, 18. *Cosmocladium*.
 - b. Each half-cell armed with a spine on each side, 19. *Arthrodesmus*.
- II. Cells orbicular, oblong or elliptical, transection flattened or elliptical, half-cells lobed,
 - a. Half-cells with few, usually rounded lobes, and broad sinuses, 20. *Euastrum*.
 - b. Half-cells with many pointed lobes and narrow sinuses, 21. *Microsterias*.
- III. Cells oblong or orbicular, transection rounded or oblong or angular,
 - a. Armed with spines, chromatophores parietal, laminiform, 22. *Xanthidium*.
 - b. Smooth, verrucose or hairy, chromatophores axial, 23. *Staurostrum*.

16. *Cosmarium* Corda. Cells solitary, short-cylindrical or orbicular, smooth, verrucose, or rarely spiny, deeply constricted in the middle; transection sub-oval or oblong, ends rounded or truncate, entire; chromatophores one or two in each half cell, axial, radiating.—Mostly small desmids of many species, widely distributed and common in mossy ponds.

17. *Pleurotaeniopsis* Lundell. Cells solitary, short-cylindrical or rounded, unarmed, deeply constricted in the middle; transection sub-oval or circular, ends rounded or truncate; chromatophores parietal, longitudinally laminiform.—Medium to large sized desmids, a few of which may be found in our quiet waters.

18. *Cosmocladium* Brebisson. Cells joined in gelatinous, dichotomously branching threads, elliptic-reniform, constricted in the middle; chromatophore one in each half-cell, central.—Small desmids of few species, but one of which has been found (in spring water) in this country.

19. *Arthrodesmus* Ehrenberg. Cells solitary, short-cylindrical or orbicular, smooth, with a single spine on each side of each half-cell, deeply constricted in the middle; transection oblong or fusiform-elliptical, ends rounded or truncate, entire; chromatophores axial, laminated.—Small to very small desmids, not common.

20. *Euastrum* Ehrenberg. Cells solitary, oblong or elliptical, with few rounded lobes and broad sinuses, smooth or verrucose, deeply constricted in the middle; transection oblong or elliptical, ends rounded or truncate, usually emarginate or deeply incised; chromatophore one in each half-cell, axial, of longitudinally radiating threads.—Small desmids of many species, widely distributed and quite common.

21. *Micrasterias* Agardh. Cells solitary, orbicular, or oblong-elliptical, deeply constricted in the middle, each half-cell with three to five radiating, pointed lobes, separated by (usually) narrow sinuses, the lobes sometimes again divided; transection fusiform, ends entire, sinuate or incised; chromatophores axial, laminated.—Large desmids, common in mossy ponds and lakes.

22. *Xanthidium* Ehrenberg. Cells solitary or geminately connected, orbicular, inflated, armed with spines, deeply constricted in the middle; transection rounded, oblong or angular, ends neither emarginate nor incised; chromatophores parietal, laminiform.—Medium to small sized desmids, apparently not common.

23. *Stauroastrum* Meyen. Cells solitary, oblong or orbicular, smooth, verrucose or hairy, deeply constricted in the middle, each half-cell in transection 3-to-6 or more angular, the angles often prolonged into obtuse or acute horn-like processes, ends mostly rounded or truncate; chromatophores axial.—Small desmids of many species, widely distributed but not abundant.

EXPLANATION OF PLATE

(All cells are drawn with their corresponding axes parallel, and are magnified about two hundred diameters.)

Plate XIX

TRIBE DESMIDIEAE.

1. Two cells of a *Gonatozygon* filament.
2. Portion of a filament of *Genicularia*.
3. Filament of *Gymonzyga*, with eight cells.
4. Three cells of a filament of *Phymatodocis*.
5. Portion of a filament (eleven cells) of *Hyalotheca*, enclosed in a thick sheath.
6. Ten cells of a filament of *Desmidium*, enclosed in a sheath.
7. Portion of a filament of *Sphaerosozoma*, enclosed in a sheath; two cells at the right just divided.
8. Filament of eleven cells of *Onychonema*, enclosed in a sheath.

TRIBE ARTHRODIEAE.

9. A cell of *Entospira*, with spiral chromatophore.
10. Cell of *Mesotaenium*.
11. Cell of *Penium*.
12. Cell of *Arthrodia*.
13. Cell of *Tetmemorus*.
14. Cell of *Docidium*.
15. A little more than one-half of a cell of *Pleurotaenium*.

TRIBE COSMARIEAE.

16. Cell of *Cosmarium*.
19. Cell of *Arthrodesmus*.
20. Cell of *Euastrum*.
21. Cell of *Micrasterias*.
22. Cell of *Xanthidium*.
23. Cell of *Staurastrum*.

PLATE XIX

